Nanofluid, Molecular Clusters and Cluster Self-Assembled Thin Films

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In this presentation we will describe unique, supercritical CO_2 based processes to prepare organic nanoparticles, which are essentially molecular clusters. The clusters exhibit novel phase and optical properties such as, room temperature liquid-like behavior, spontaneous self-assembling tendencies, process dependant photoluminescence and super hydrophobicity.

We will present evidence for a novel nanostructured fluid, composed of molecular clusters of a polar organic dye and surfactant. These are **not** nanoparticles dispersed in a solvent and there are no solvent molecules present. These materials, which are solids under ambient conditions, are non-reactively precipitated from a compressed CO_2 solution resulting in a liquid-like material, which we call nanofluid. The precipitated dye-surfactant clusters are 1-4nm in size and exhibit intense luminescent signatures, which are significantly blue-shifted with respect to the dye powder or a solution of it. The X-ray diffraction pattern did not show any structure in the low-angle regime. We believe that the ultra fast and controlled precipitation from compressed CO_2 preserves the electrostatic coupling and promotes a structured molecular cluster.

We also demonstrate the strong tendency of compressed CO_2 precipitated organic nanoparticles to rapidly self-assemble into highly aligned super-lattices at room temperature, when solution-cast from dispersions or spray-coated directly onto various substrates. The nanoparticles dispersions are stable for years. The novel precipitation process used is believed to result in molecular distances and alignments in the nanoparticles, which are not normally possible. Self-assembled thin films of these novel materials exhibit lamellar structures and coatings on cloth and stainless steel have been found to be superhydrophobic in nature.

Functional OLEDs - which have the same host-dopant emissive material combination as their vacuum fabricated checks- with process tunable electro luminescence, have been built with these nanoparticles, indicating the presence of novel nanostructures. For example, only changing the conditions of the precipitation process changes the OLED emission from green light to yellow.